CSC 261/461
Database Systems

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Database Design

Requirements

- Requirements of the COMPANY Database:
- The company is organized into DEPARTMENTs.
- Each department has a name, number and an employee who manages the department. We keep track of the start date of the department manager.
- A department may have several locations.
- Each department controls a number of PROJECTs.
- Each project has a unique name, unique number and is located at a single location.

Database Design

Requirements

- The database stores each EMPLOYEE's social security number, address, salary, sex, and birthdate.
- Each employee works for one department but may work on several projects.
- The DB will keep track of the number of hours per week that an employee currently works on each project.
- It is required to keep track of the direct supervisor of each employee.
- Each employee may have a number of DEPENDENTs.
- For each dependent, the DB keeps a record of name, sex, birthdate, and relationship to the employee.

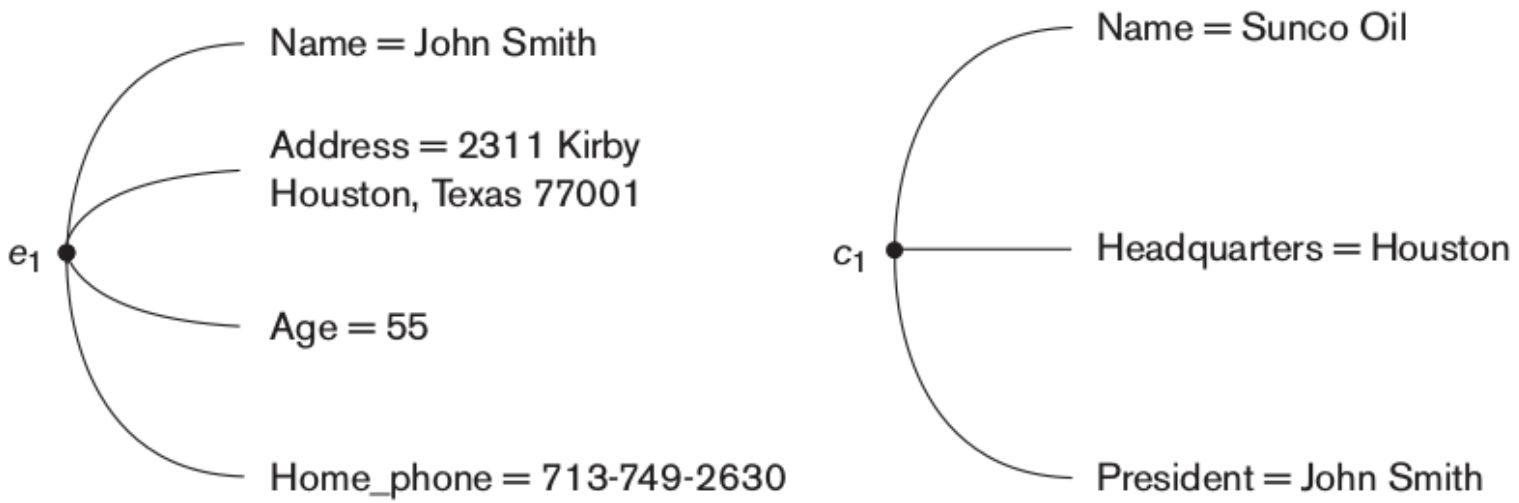
ER Model Concepts

Entities and Attributes

- *Entity* is a basic concept for the ER model.
- Entities are specific things or objects in the mini-world that are represented in the database.
  - the EMPLOYEE John Smith, the Research DEPARTMENT, the ProductX PROJECT
- *Attributes* are properties used to describe an entity.
  - an EMPLOYEE entity may have the attributes Name, SSN, Address, Sex, BirthDate
- A specific entity will have a value for each of its attributes.
  - a specific employee entity may have Name='John Smith', SSN='123456789', Address ='731, Fondren, Houston, TX', Sex='M', BirthDate='09-JAN-55?
- Each attribute has a value set (or data type) associated with it.

ER Model Concepts

Entities and Attributes



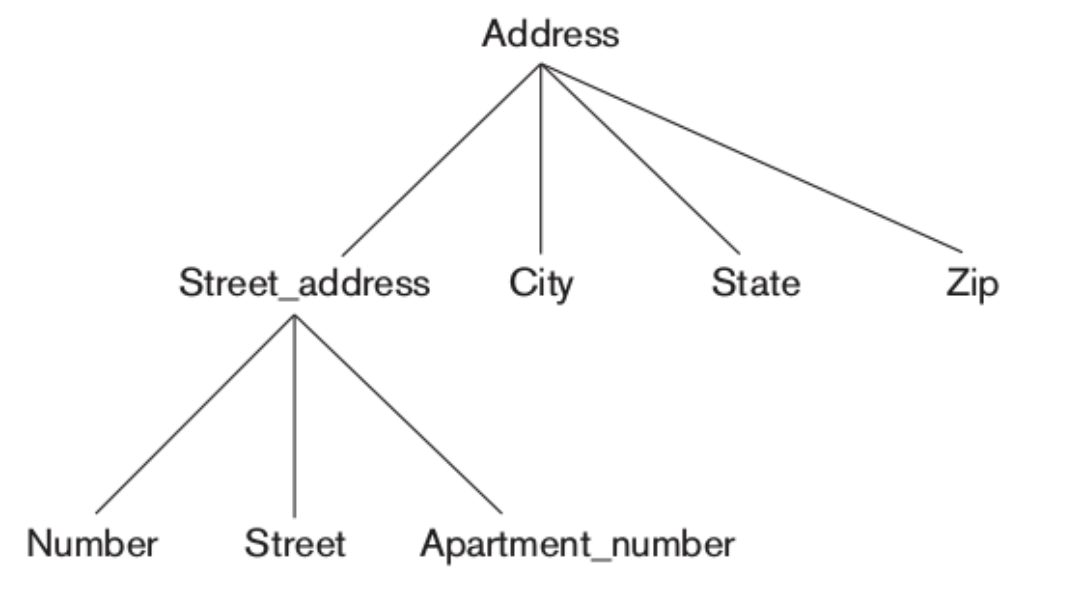
ER Model Concepts

Entities and Attributes

- `Simple`: a single atomic (not divisible) value for the attribute: SSN or Age.
- `Composite`: The attribute may be composed of several components.
  - Name(FirstName, MiddleName, LastName)
  - Composition may form a hierarchy where some components are themselves composite.

ER Model Concepts

Composite Attributes



ER Model Concepts

Entities and Attributes

- `Multi-valued`: An entity may have multiple values for that attribute.
  - Color of a CAR or PreviousDegrees of a STUDENT.
  - Denoted as {Color} or {PreviousDegrees}.
- composite and multi-valued attributes may be nested arbitrarily to any number of levels
  - PreviousDegrees of a STUDENT is a composite multi-valued attribute denoted by {PreviousDegrees (College, Year, Degree, Field)}

Database Design

Entities and Attributes

- Entities with the same basic attributes are grouped into an `entity type`.
  - the entity type EMPLOYEE and PROJECT.
- An attribute of an entity type for which each entity must have a unique value is called a `key` attribute of the entity type.
  - SSN of EMPLOYEE.

Database Design

Keys

- A key attribute may be composite.
  - `VehicleTagNumber` is a key of the CAR entity type with components (Number, State).
- An entity type may have more than one key.
  - The CAR entity type may have two keys: `VehicleIdentificationNumber` and `VehicleTagNumber (Number, State)`.
- each key is underlined.

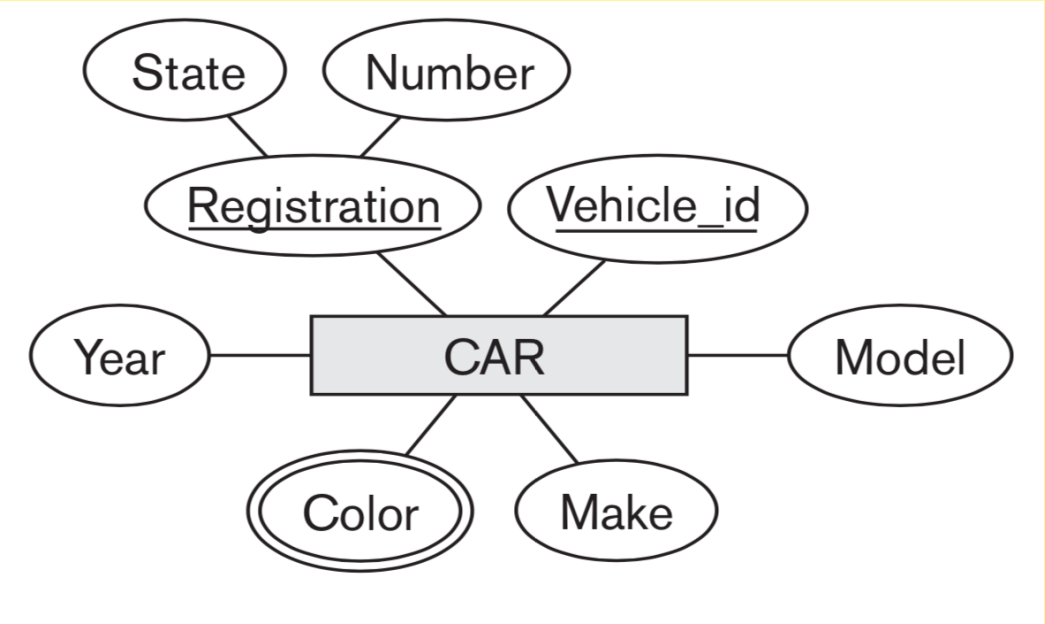
Database Design

Entity-Relationship Diagram

- In ER diagrams, an entity type is displayed in a `rectangular` box
- Attributes are displayed in `ovals`
- Each attribute is connected to its entity type
- Components of a composite attribute are connected to the oval representing the composite attribute
- Each key attribute is underlined
- Multivalued attributes displayed in `double ovals`.

Example

Example



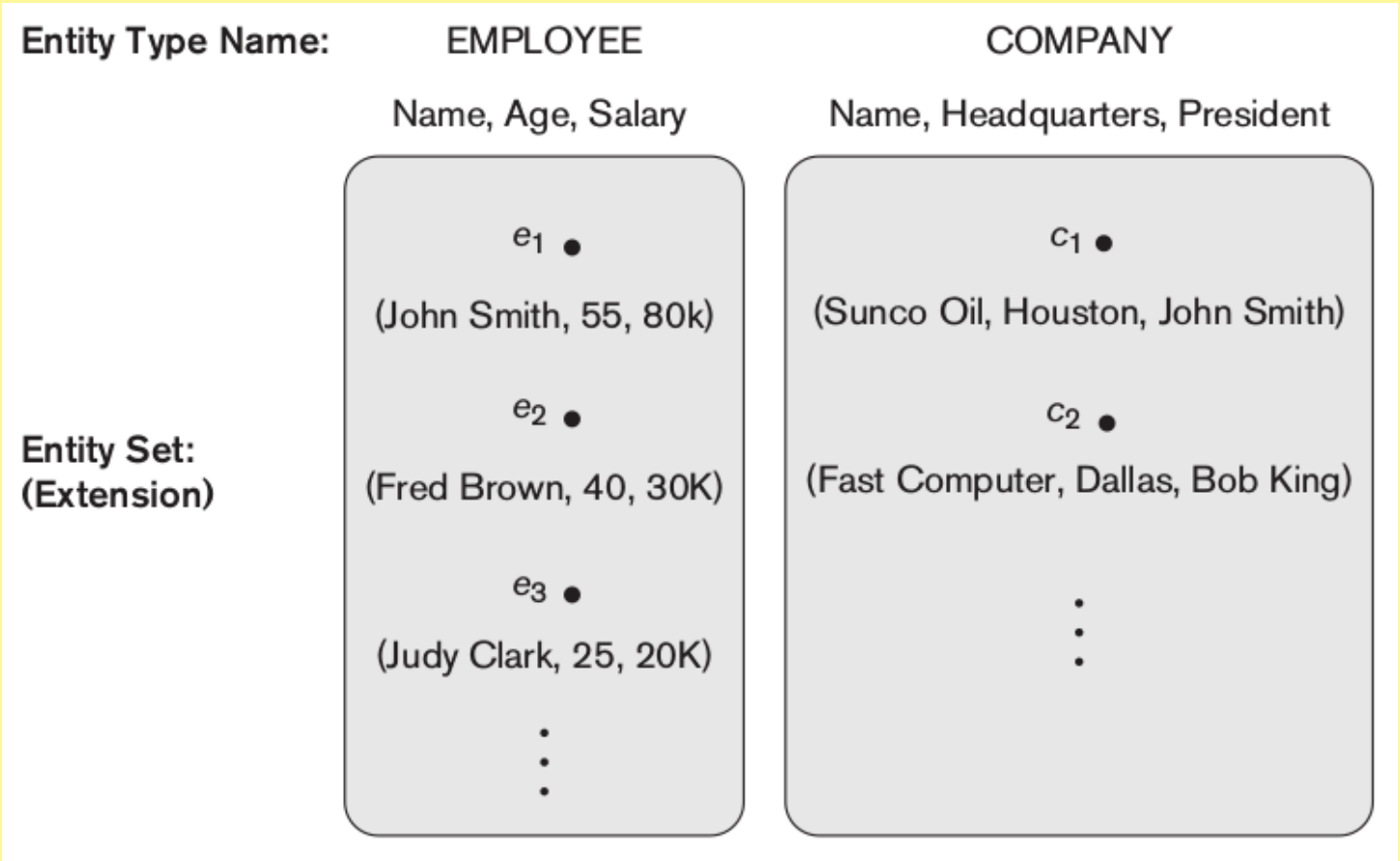
Database Design

Entities and Attributes

- each entity type will have a collection of entities stored in the database
  - called `entity set` or entity collection
- Entity set is the current state of the entities of that type that are stored in the database

ER Model Concepts

Composite Attributes



Database Design

Entities and Attributes

- Each simple attribute is associated with a *value set*
  - Lastname has a value which is a character string of up to 15 characters
  - Date has a value consisting of MM-DD-YYYY where each letter is an integer
- A value set specifies the set of values associated with an attribute

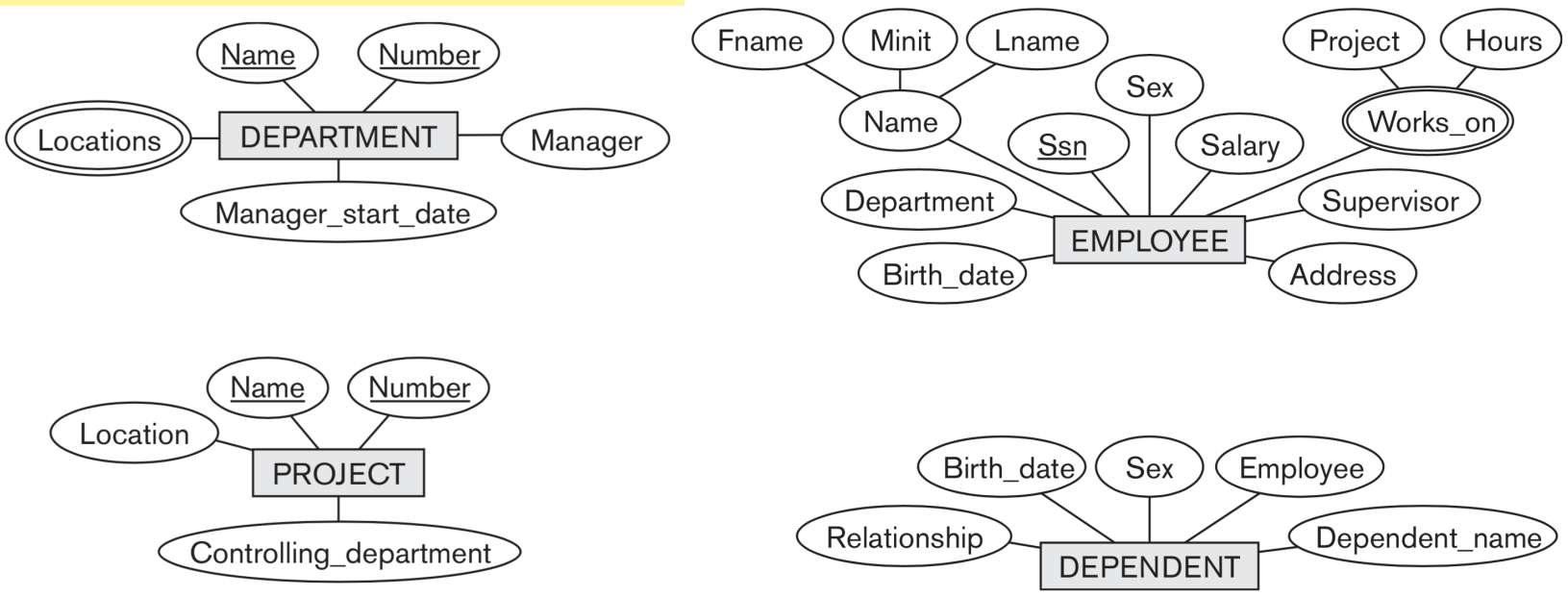
Database Design

Entities and Attributes

- Based on the requirements, we can identify four initial entity types in the COMPANY database:
  - DEPARTMENT
  - PROJECT
  - EMPLOYEE
  - DEPENDENT

Example

Example



Database Design

ER model

- ER model has three main concepts:
  - Entities (and their entity types and entity sets)
  - Attributes (simple, composite, multivalued)
  - Relationships (and their relationship types and relationship sets)

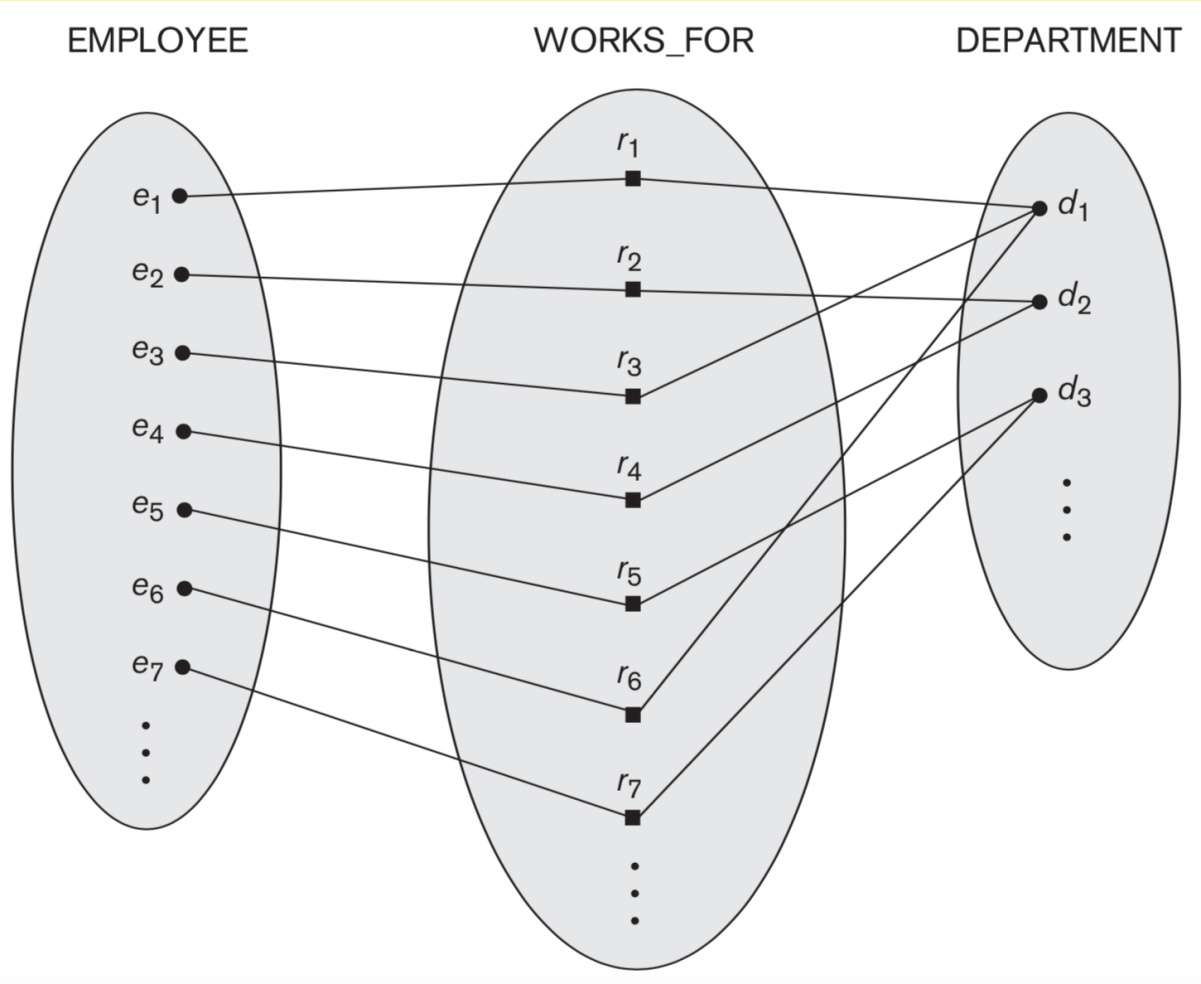
Database Design

Relationships

- A relationship relates two or more distinct entities with a specific meaning.
  - EMPLOYEE John Smith works on the ProductX PROJECT
  - EMPLOYEE Franklin Wong manages the Research DEPARTMENT.
- Relationships of the same type are grouped into a `relationship type`.
  - WORKS_ON relationship type in which EMPLOYEEs and PROJECTs participate
  - MANAGES relationship type in which EMPLOYEEs and DEPARTMENTs participate.
- The *degree* of a relationship type is the number of participating entity types.
  - Both MANAGES and WORKS_ON are binary relationships.

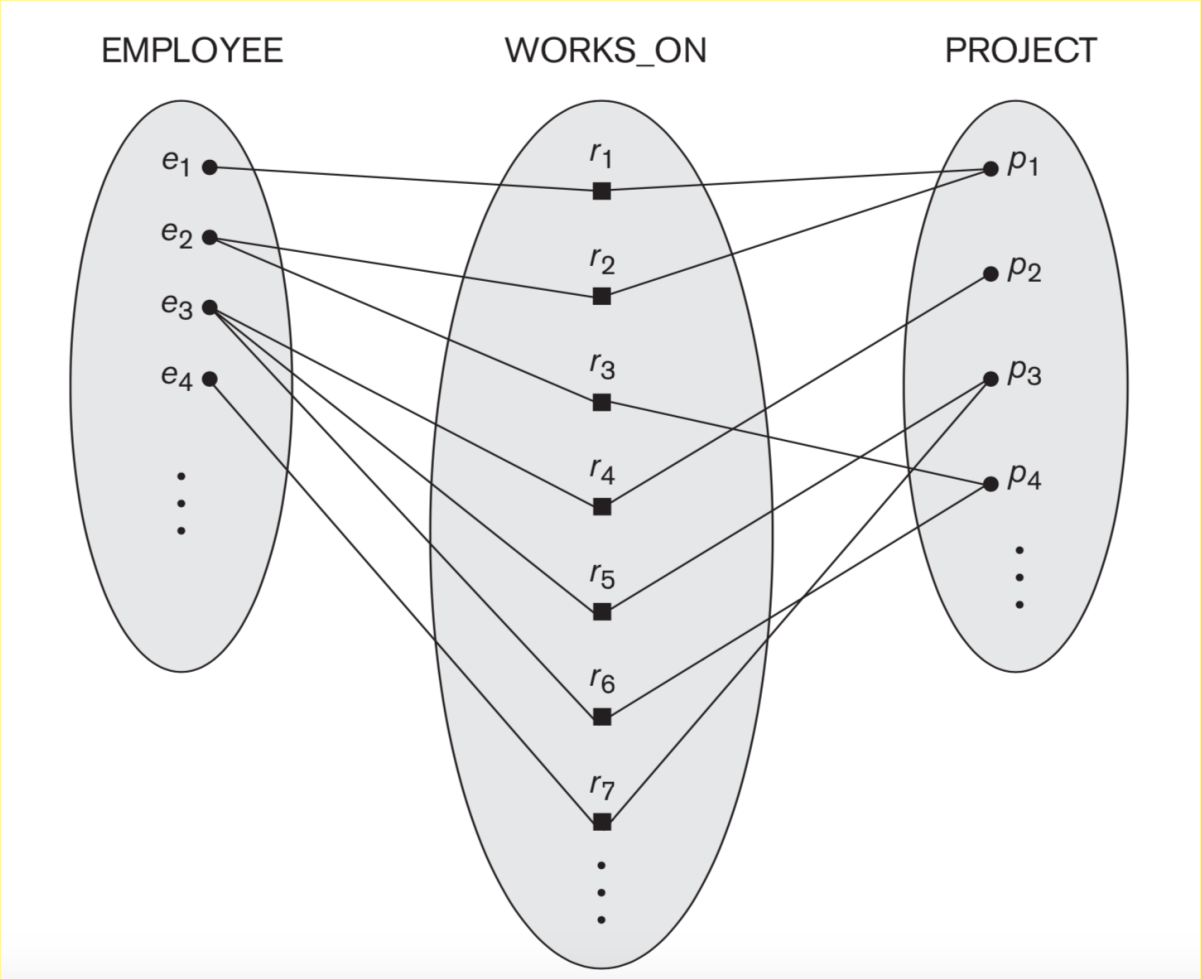
Example

Example



Example

Example



Database Design

Relationship type vs. relationship set

- Relationship Type:
  - Is the schema description of a relationship
  - Identifies the relationship name and the participating entity types
  - Identifies certain relationship constraints
- Relationship Set:
  - The current set of relationship instances represented in the database
  - The current state of a relationship type

Database Design

Relationship Sets

- in a relationship set each instance relates individual participating entities
- In ER diagrams, we represent the relationship type as follows:
  - Diamond-shaped box is used to display a relationship type
  - Connected to the participating entity types via straight lines

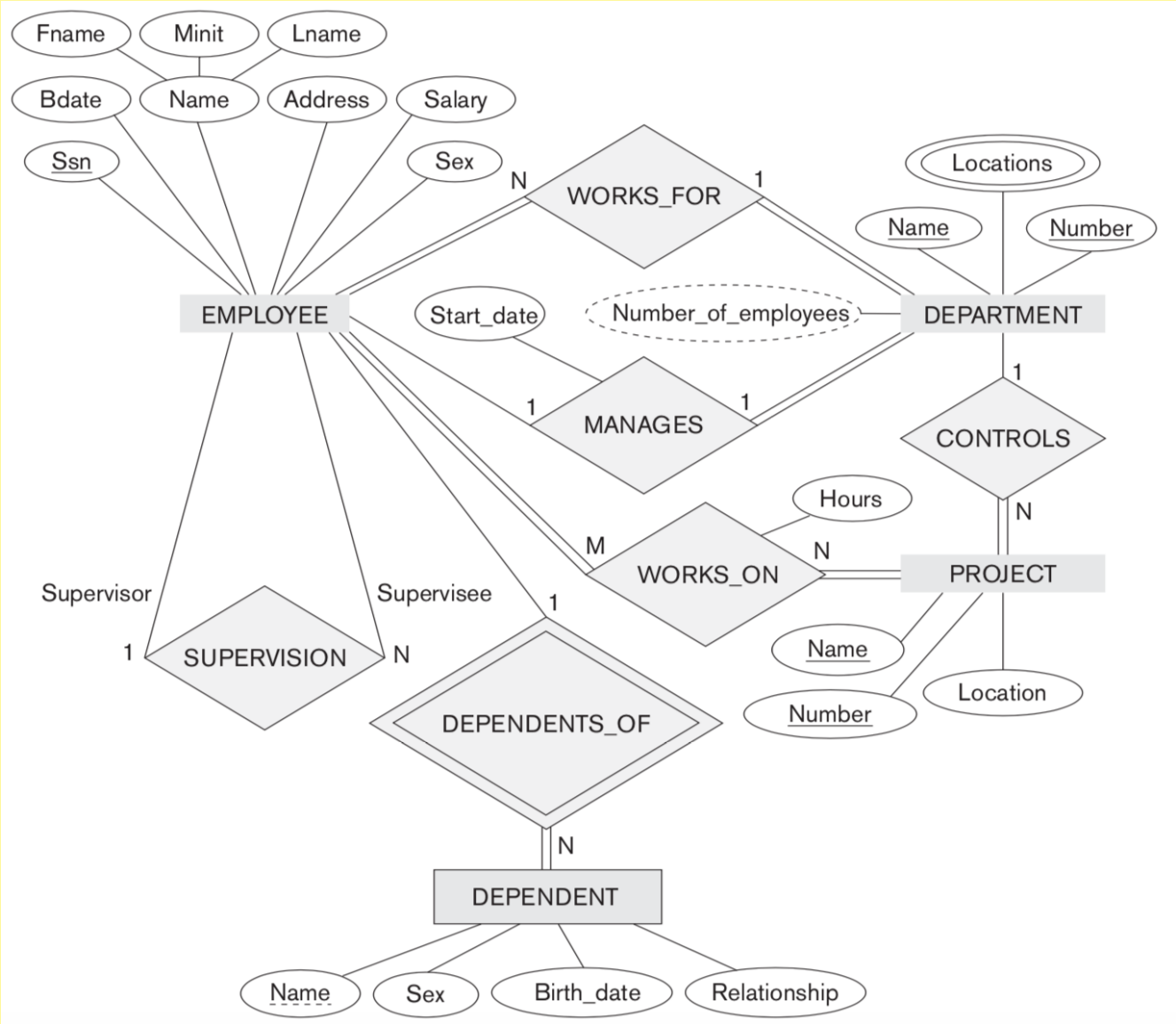
Database Design

Relationship types

- WORKS_FOR (between EMPLOYEE, DEPARTMENT)
- MANAGES (also between EMPLOYEE, DEPARTMENT)
- CONTROLS (between DEPARTMENT, PROJECT)
- WORKS_ON (between EMPLOYEE, PROJECT)
- SUPERVISION (between EMPLOYEE (as subordinate), EMPLOYEE (as supervisor))
- DEPENDENTS_OF (between EMPLOYEE, DEPENDENT)

Example

Example



Questions?